Table 4-1. Stressors Identified in the Habitat and Terrestrial Wildlife Chapters of LaMP 2000

Stressor	Examples of Species Affected	Examples of Habitat Structure or Function Affected	Examples of Communities Affected
Contaminants	fish-eating animals	increased mortality rates	aquatic communities
Dam construction	spawning fish, wild rice	stream flow, lake level increases	aquatic and wetland communities
Eutrophication	rare aquatic species	increased competition	submerged and emergent wetlands
Fire suppression	sharp-tailed grouse	fires that set back succession, nutrient cycling	boreal forests, pine barrens
Fragmentation	neotropical migrants	increased predation, isolation effects	mesic forest community
Global climate change	reptiles and amphibians	increased mortality rates	all communities
Groins, dykes, breakwalls	native plant communities and wetlands	sedimentation and nutrient cycling reduction	coastal wetland communities
Invasive exotic species	native plants	increased competition	aquatic, wetland, and upland forests
Logging	caribou	habitat simplification	boreal forests
Loss of conifers	neotropical migrant birds	loss of protective cover	mesic forest community
Overabundant species	yew, hemlock	increased herbivory	northern forest communities
Recreation	loons, shore birds (plovers)	increased disturbance	lakes and lakeshores
Road construction and maintenance	Fish and aquatic plants and animals	sedimentation	northern forest communities
Shoreline residential development	reptiles and amphibians, some migratory birds	habitat simplification	lakeshores, dunes
Water level manipulation	wild rice	reduction of water-related disturbance events	coastal wetland communities

GIS Mapping of Lake Superior Fish Spawning and Nursery Areas

The Great Lakes Indian Fish and Wildlife Commission (GLIFWC) has utilized a GIS to identify historic spawning and nursery areas of Lake Superior fish. The GIS data have been used to create maps of 1,566 Lake Superior spawning sites for various species of interest. The maps generated have been produced at a lake-wide scale, along with 41 detailed maps giving more precise locations. The Lake Superior spawning and nursery locations will be made available through GLIFWC's internet map server, allowing public viewing of information for fish species in combination with other information on navigation routes, lake bathymetry, and the lake and rivers in the Lake Superior watershed.

Contact Sandra Hellman at 312-353-5006 or e-mail at *hellman.Sandra@epa.gov*
or Duane Heaton at 312-886-6399 or e-mail at *heaton.duane@epa.gov*

The St. Louis River estuary provides habitat for colonial waterbirds such as common terns and great blue herons. Its wetlands, bays, and river channels are important spawning areas for fish such as lake sturgeon and walleye. Migrating birds use the estuary as a critical stopping point in both spring and fall.

Photograph by Eric Epstein, Wisconsin Department of Natural Resources

aquatic portions of the Lake Superior ecosystem. A few of those indicators are included in Table 4-1.

Although this section does not assess all the stressor indicators described above, it does address the current status of four components of the Lake Superior ecosystem: open lake, wetlands, upland communities, and inland lakes and tributaries. This section also reviews some of the accomplishments in managing ecosystem stressors since LaMP 2000.

Ecosystem Status

Open Lake and Nearshore Waters

Overall, the aquatic community of Lake Superior more closely resembles the original community of the lake that existed prior to European settlement than any of the other Great Lakes. However, the aquatic community continues to face significant human-induced stresses that reduce its diversity and impede its proper functioning. Sea lampreys continue to kill many fish, and shoreline development slowly continues to reduce and alter available habitat. Although toxic chemicals have minimal effects on the abundance of fish in Lake Superior, the chemicals continue to enter the lake and accumulate in fish to the point where consumption advisories are necessary to protect human health.

Effluent from mining operations, pulp and paper mills, and other industrial sources continues to be a problem in urban areas and elsewhere. Chemical and biological pollutants continue to enter the waters of Lake Superior, limiting reproduction of aquatic organisms, and damaging nearshore habitat. Effluent from the pulp and paper industry has resulted in accumulation of contaminated sediment, habitat loss, degradation of nearshore areas, and loss of species abundance and diversity. These discharges contributed to the creation of many of the AOCs.

In Canada, the federal and Ontario pulp and paper regulations have led to significant improvement in the quality of the effluent from pulp and paper mills. Biochemical oxygen demand levels have decreased by over 90 percent, effluents are non-acutely lethal and no longer contain measurable concentrations of 2, 3, 7, 8-TCDD. Sub-lethal toxicity data obtained

Monitoring of Aquatic Ecosystems

Photograph by Patrick T. Collins, Minnesota Department of Natural Resources

Many coordinated, long-term monitoring programs are in place to assess Lake Superior's aquatic ecosystem. A few examples include the following:

- A coordinated, long-term monitoring program to evaluate populations of lake trout in Lake Superior has been in place since the late 1950s. State and provincial agencies and Tribes/First Nations conduct spring gill net surveys of lake trout. Results from these surveys are used to set harvest limits and stocking policies, evaluate the effectiveness of the sea lamprey control program, and determine interactions between native and nonindigenous species both within and among jurisdictions.
- The federal governments monitor the abundance of adult sea lampreys in Lake Superior and larval lamprey in tributaries. This information is used to assess the effectiveness of the sea lamprey control program.
- State agencies monitor the abundance of trout and salmon in tributaries to Lake Superior.

through the federal, regulated environmental effects monitoring program (EEM) indicate that the installation of secondary treatment at Ontario mills has significantly lowered the sub-lethal toxicity of pulp mill effluent to aquatic organisms. Subsequent to the installation of secondary treatment and other process changes at the Jackfish Bay, Ontario, mill some improvements were noted; however, fish collected in 2000 still exhibited some signs of altered reproductive function. Research work to characterize effluent compounds and evaluate the effectiveness of current treatments is ongoing. The effectiveness of the regulations in protecting the aquatic communities downstream will continue to be assessed through the EEM program.

Hydroelectric facilities that generate power using dams on rivers can also stress aquatic life. By reducing the need for coal-fired power plants, this energy source helps reduce toxic loadings, but it can also artificially alter river flows and degrade habitat for aquatic creatures. In addition, hydroelectric plants hold water in summer, which leads to an increase in the temperature of the remaining,

The Fall and Rise of the Lake Trout

Lake trout once supported a major commercial and small sport fishery in the Great Lakes. By the 1950s, the lake trout was nearly extinct because of overfishing and predation from the sea lamprey. Annual harvesting of lake trout fell from about 17 million pounds to next to nothing. For some time, it was unclear whether the lake trout would survive in the Great Lakes.

During the 1950s, state, provincial, and federal governments began stocking lake trout, placed limits on sport and commercial fishing, coordinated sea lamprey control, and worked to improve Great Lakes water quality. The program has been a great success. Today, Lake Superior is the only Great Lake that supports a self-sustaining lake trout population.

shallower water. This in turn leads to reduced dissolved oxygen levels and thus affects aquatic life.

Success Stories/Remaining Challenges

This section addresses successes and remaining challenges in restoring aquatic native species and controlling aquatic nuisance species. Contaminated sediments are also a source of impairment in Lake Superior; they are addressed in Section 3.

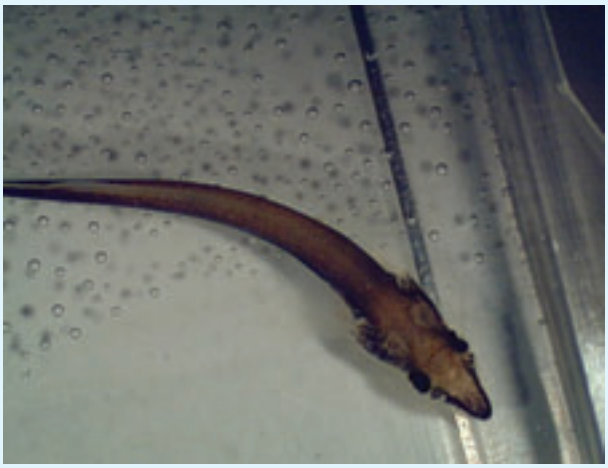
Restoring Native Aquatic Species

Great successes have been achieved in restoring native fish populations in Lake Superior. After years of effort, greater numbers of naturally reproducing lake trout are present in Lake Superior than in all the other Great Lakes combined.

The success with lake trout restoration has allowed the focus to shift to restoring other aquatic species, including brook trout, walleye, and lake sturgeon. Although brook trout, walleye, and lake sturgeon have not yet reached their historical population levels, they are making a comeback in Lake Superior. Much of this success is attributable to local communities and fishery agencies that are taking a lead in restoring tributaries to the lake, where fish are once again spawning. Examples of restoration projects include the following:

- The Central Lake Superior Watershed Partnership is restoring critical habitat along and within the Salmon-Trout River. Working with funds received from the U.S. Fish and Wildlife Service and U.S. EPA, this consortium of private, public, and citizen groups is working to enhance resident populations of coaster brook trout.
- A Nipigon River water management plan was created to regulate input and output of water by hydroelectric facilities on the Nipigon River in Ontario. This plan was developed specifically to restore the coaster brook trout, the original native species of brook trout in the Great Lakes. The plan successfully defined the minimum flows necessary to promote reproduction by coasters in the Nipigon River. A new harvest restriction establishing a daily bag limit of one fish of 51 centimeters or greater total length was instituted to better protect mature coaster brook trout.
- Wisconsin DNR is working with local watershed groups and other partners to implement its Lake Superior Basin Brook Trout Management Plan through protecting tributary watersheds.

The most effective strategies for restoring native fish in Lake Superior require strong local participation as well as cooperation with agencies at various levels of government. Restoration efforts must be conducted on a watershed scale to ensure that



A larval lake sturgeon captured in the White River. It is a product of reproduction in the wild.
Photograph by William Mattes,
Great Lakes Indian Fishery and Wildlife Commission

spawning grounds are restored, allowing the species to reproduce in a self-sustaining manner.

Controlling Aquatic Nuisance Species

One of the greatest threats to the restoration and viability of native aquatic species in Lake Superior is aquatic nuisance species, or invasive exotic species.

Sea lampreys and alewives entered Lake Superior because of construction of the Welland Canal, while more recent arrivals such as the zebra mussel, round goby, and ruffe entered the lake through ballast water release. Humans purposely introduced other species such as the Pacific salmon, carp, and brown trout into Lake Superior for sport fishing purposes.

To reduce sea lamprey abundance in Lake Superior, governments have been using various integrated measures. One such control measure is use of barriers to prevent movement of the sea lamprey into tributary rivers and streams, where the lamprey spawn. However, in addition to stopping new infestations of lampreys, these barriers prevent movement of native species into tributaries and reduce the diversity of native fish species. Barriers can also protect native lamprey from lampricides. Barrier technology has evolved such that inflatable crest barriers are now used and only for a few months of the year. Specially formulated chemicals are used to target and kill larval sea lampreys, but these chemicals sometimes also kill native invertebrates and fish.

The sea lamprey attaches itself to fish with its mouth. Photograph courtesy of U.S. Fish and Wildlife Service

No Ballast on Board (NOBOB) Vessels

U.S. EPA is jointly working on a project with the National Oceanic and Atmospheric Administration (NOAA) and the U.S. Coast Guard to examine the impact of NOBOB vessels as a significant vector for the introduction of invasive aquatic species. NOBOB vessels account for over 75 percent of the vessels entering the Great Lakes each year. Although they do not contain ballast water, these vessels do have a large amount of sludge and sediment at the bottom of their tanks that have the potential to harbor a whole community of aquatic organisms. The project will examine the potential risk of discharges from these unregulated NOBOB vessels.

The Great Lakes Fishery Commission (GLFC) is a critical partner in achieving a balanced and healthy fish community in Lake Superior, both in terms of controlling exotic species and rehabilitating native species in the lake. GLFC has adopted and implemented an integrated management of sea lamprey (IMSL) approach to control sea lamprey in the Great Lakes. The IMSL process involves using a variety of control methods instead of relying solely on chemicals. For example,

- GLFC is reducing the minimum lethal concentrations of chemicals used to kill larval sea lampreys in order to protect young lake sturgeon and is scheduling chemical treatments later in the summer to reduce the effects on young lake sturgeon. GLFC has reduced chemical use by 50 percent compared to the amounts used in the 1990s.
- GLFC is also using sterile-male releases to impede the reproductive success of sea lampreys, conducting mark-and-recapture studies with juvenile and adult sea lampreys to measure population trends, and researching other strategies to reduce populations of sea lampreys without harming other parts of the ecosystem.
- GLFC technical committees have also developed lakewide lake trout population models that estimate total allowable catches of lake trout, evaluate various fishery management strategies,

and estimate damage by sea lampreys to lake trout populations.

Despite the great progress made, sea lampreys continue to kill many fish each year, threatening the restoration of lake trout to Lake Superior. The principal challenge in controlling the sea lamprey and other exotic species in the lake lies in balancing the use of effective control measures for exotic species with preservation and restoration of native species.

Since the publication of LaMP 2000, two additional recommendations have been made by the Great Lakes community to address aquatic nuisance species:

1. Continue to develop and promote the use of technologies to safely and effectively treat ballast water discharges

2. Investigate the possibility of developing a "rapid response" team with the authority to make effective decisions on how to best respond to a new invader once discovered.

An additional important activity is the work of the Great Lakes Panel (GLP) on aquatic nuisance species. In March 2001, the GLP finalized a "Policy Statement on Ballast Water Management to Control Aquatic Nuisance Species." The objectives of the policy are to (1) eliminate ballast associated with aquatic nuisance species introductions into waters of the Great Lakes-St. Lawrence River system and (2) reduce aquatic nuisance species dispersal between the lakes through regional development and application of a timely, effective, scientifically sound, and economically viable binational water management program.

In summer 2001, the GLP finalized "A Great Lakes Action Plan for the Prevention and Control of Nonindigenous Aquatic Nuisance Species." The overall goals of the plan are to raise the visibility of the aquatic nuisance species issue in the Great Lakes and to enhance the health of the Great Lakes ecosystem by designing and implementing timely and effective prevention and control measures. The plan has been signed by all eight governors and two premiers in the Great Lakes-St. Lawrence River region.

Wetlands

Wetlands in the Lake Superior basin feed water and nutrients to lakes and streams, a process that is critical for upper food chain animals such as migratory birds and fish as well as humans. Because Lake Superior is so deep, cold, and otherwise inhospitable to many warm-water aquatic animals, these wetlands are critical for keeping the lake alive. Wetlands are found in the Lake Superior basin at all elevations but are prevalent at upper reaches of streams; along slow-moving stretches of streams; in large, shallow depressions in the landscape; and on the Lake Superior coastline.

The greatest threats to Lake Superior's wetlands are water level regulation and site-specific stresses such as shoreline development. Modified water

Sanctuary Island
Thunder Bay, Ontario

Constructed during the winter of 1993, this crescent-shaped island is designed to foster natural development of a wetland and restore some diversity to an area affected by harbour development. The island is 205 meters long and was built using 25,000 tons of quarry stone. Underwater features, such as rock shoals and sediment traps, and pockets of topsoil add habitat value to the standard armour stone berm construction. Birds are now nesting on the island, waterfowl are often found in the inner bay, and fish are using the new habitat. A "Name the Island" contest held in local schools drew 114 entries. The winning name, Sanctuary Island, was submitted by a 9-year old girl.

Photograph courtesy of
Ontario Ministry of Natural Resources

Students restoring native plants at Sugarloaf Cove
Photograph by Diane Destolle

Sugarloaf Cove: A Unique Restoration

A joint effort between the Minnesota Department of Natural Resources and the Sugarloaf Interpretive Center Association (SICA) restored coastal wetland and upland habitats at the Sugarloaf Point Scientific and Natural Area and surrounding property owned and managed by SICA.

Long ago, the bedrock island just offshore at the site became connected to the mainland by a pair of gravel beaches, forming what is known as a tombolo. This protected the enclosed wetland area from the energy of the lake and allowed a wetland plant community to develop. The tombolo also formed a natural protected cove that was used from the 1940s through the 1970s by Consolidated Paper. The site was used to create log rafts bound for Ashland, Wisconsin where they were loaded on railcars headed for inland paper plants. During the time the land was used for moving logs, low areas were filled and much of the forest was cut so that buildings and roads could be constructed. When the paper company stopped using the site, most of the buildings were removed.

After being considered as a site for a safe harbor development, the Sugarloaf Point natural area was expanded and the surrounding land came under the management of the nonprofit Sugarloaf Interpretive Center Association. Restoration of native plant communities is a priority both for SICA and for the DNR's Division of Ecological Services which manages the natural area. Cooperation between the DNR and SICA, as well as grant money from the EPA's Great Lakes National Program Office, allowed a thorough survey of remaining natural plant communities as well as an investigation under the surface of the fill placed on the wetland in the past. Using the results of these surveys to carefully define restoration targets for both uplands and wetlands, restoration began in earnest in 1999. Fill removed from over the wetland soil was used to restore upland areas such as an old road site.

The strong educational focus of the Sugarloaf Interpretive Center Association will assure that the lessons learned in restoring wetland and upland plant communities on the shores of Lake Superior are available to residents and visitors alike.

Photograph by Patrick T. Collins,
Minnesota Department of Natural Resources

Whittlesey Creek Watershed

Photograph courtesy of
Wisconsin Department of Natural Resources

The Whittlesey Creek Watershed project is designed to protect coastal wetlands, restore habitat in the watershed, and involve both citizens and agencies. The project was initiated by the Bayfield County Land Conservation Committee using state nonpoint source pollution funds. A plan for improving watershed health was developed. Since 1996, Wisconsin has provided over $120,000 to cost share with landowners to restore wetlands, re-plant critical habitat, and stabilize eroding stream banks. Whittlesey Creek National Wildlife Refuge was established in 1999 to protect coastal wetlands and restore wetland and stream hydrology. Private landowners are given technical and financial assistance for habitat restoration projects that improve both aquatic and terrestrial community health in the watershed. State, federal, and nonprofit organizations are working cooperatively to restore the native coaster brook trout to Chequamegon Bay and Whittlesey Creek. A fishery assessment of Whittlesey Creek was conducted in summer 2001 as a precursor to restoration work. The U.S. Fish and Wildlife Service is offering to purchase conservation easements from landowners in the watershed to protect fish and wildlife habitat. Bayfield County and the U.S. Geological Survey are completing a hydrologic study of surface water and groundwater flows and of the effects of land use on those flows. The study results will help direct future habitat protection and restoration work.

level fluctuations pose significant threats to Lake Superior wetlands because they alter the community composition of native animal and plant life in and near wetlands. Lake Superior's coastal wetlands rely on natural fluctuations in water levels associated with daily and annual cycles to maintain their biological diversity and productivity. Native aquatic species also face difficulties because the increased loss of wetlands degrades water quality, damages aquatic habitat, and impedes fish reproduction.

Many important plants and animals in the Lake Superior basin depend on wetlands for all or part of their life cycles. For example, wild rice is a culturally important plant in the basin even though its distribution is not extensive. Although a number of factors can harm wild rice, it is particularly sensitive to water level changes. Many lakes and rivers have been dammed, and even small water level changes can destroy wild rice habitat.

Success Stories/Remaining Challenges

Many wetland protection and restoration efforts have been driven by changes in state and provincial laws and by local communities (such as the Whittlesey Creek Watershed project and the Sugarloaf Cove restoration). In addition, the Michigan Upper Peninsula Coastal Wetlands Partnership has protected or restored several thousand acres of wetlands. New laws and locally driven projects are accelerating wetland protection and restoration, but challenges remain as the drive to fill and develop wetlands continues.

Upland Communities: Terrestrial Flora and Fauna

Terrestrial flora and fauna occur on lands not covered by standing water. These uplands encounter stresses similar to those faced by wetlands-primarily land use and land development changes. Habitat and land use changes have significantly affected uplands in the Lake Superior basin, especially over the last 150 years. In the three states bordering Lake Superior, timber harvesting, land clearing for agriculture, and fires caused by the advance of settlement removed almost all the pre-existing forest cover. Similar land-clearing for settlements and agriculture occurred in the eastern (Sault Ste. Marie) and western (Thunder Bay) portions of the basin in Ontario. Forest cover in the northern basin area of Ontario has primarily been influenced by forest fires, lumber harvesting,

Michigan Upper Peninsula Coastal Wetlands Partnership
Two Rounds of Success

This highly successful partnership of some 15 local natural resource entities, communities, and tribes has performed nearly $8,000,000 worth of work to protect, restore, and manage coastal wetlands and associated uplands in the Lake Superior and St. Marys River watersheds. Working in two phases, the partnership has obtained nearly $2,000,000 in North American Wetlands Conservation Act (NAWCA) grant funds (in two phases) and has provided nearly $6,000,000 in matching funds and activities.

The initiative brought together all the major natural resource entities in the basins to begin breaking down barriers in working relationships and to combine technical, biological, and cultural expertise in order to create the most efficient working group to address resource needs. This working group has identified coastal shoreline areas on Lake Superior and on river corridors as being threatened by fragmentation and development. Preventing the destruction of these areas has been a priority for the partnership in Phases I and II of the work.

Phase I Accomplishments:

- 1,237 acres of wetlands and 1,573 acres of associated uplands protected from development
- 7,847 feet of Lake Superior shoreline protected from development
  -- including 3,347 feet of "essential" breeding habitat for piping plover recovery
- 77 acres of wetlands restored in the Rudyard Clay Plain

Phase II Accomplishments:

- 1,619.4 acres of wetlands and 1,689.97 acres of associated uplands protected, including breeding habitat for a variety of waterfowl; wetland-dependent, threatened, and endangered species (the piping plover); fish (the coaster brook trout); and wildlife
- Approximately 4,000 feet of Lake Superior shoreline protected
- River frontage on the Gratiot River, Presque Isle and Yellow Dog Rivers protected
- 144 acres of acquired lands enhanced
- 86 acres of wetlands restored
- 76 acres of wetlands enhanced

road and rail construction, and, to a lesser degree, mining activities. Restoration is thus complicated by uncertainty regarding how reintroduced native species will respond to these changes in the ecosystem.

Forest fragmentation occurs when large blocks of forest are broken up into smaller forest patches. This is happening at an increasing rate in the Lake Superior basin. Dividing a forest into fragments with cleared land, roads, and developments makes the fragments more vulnerable to ecological stress. Stressors such as overabundant wildlife species and habitat isolation are more likely to adversely affect smaller patches of forest. Moreover, animals in forest edges experience greater rates of predation than animals in areas deeper in the forest because of these exposures. Forest fragmentation and

Moose on the shore of Isle Royale National Park
Photograph by Glenn Miller, US Fish and Wildlife Service

Photograph courtesy of Canadian Wildlife Service

Peregrine Falcon

loss of mature forest cover threaten forest-dwelling birds such as the veery, black-and-white warbler, ovenbird, and northern waterthrush, as well as some medium-sized carnivores such as the American marten. In Ontario, forest fragmentation and increased access to the forest have contributed to the reduction in woodland caribou range.

Species relying on more open habitat are also under stress. Fire suppression has allowed increased conversion of some upland habitat that was previously maintained in more open conditions (such as pine barrens) and has resulted in a decline of open habitat- dependent species like the sharp-tailed grouse and upland sand piper.

Where they can dominate the landscape, invasive exotic plant species are beginning to cause a reduction in diversity. Prevention and control measures are necessary to address these species, but little work has been done to survey the extent

Lake Nipigon Basin Signature Site

The Lake Nipigon Basin Signature Site was identified as one of nine featured areas under Ontario's Living Legacy as having a range of highly significant values that warrant special strategies. Ontario's Living Legacy Land Use Strategy resulted from an intensive provincial Lands for Life planning process. The resulting Land Use Strategy (LUS) provides direction regarding land designations, permitted land uses, and future planning and consultation needs. Planning decisions presented in the LUS govern development of objectives and options during the signature site planning exercise.

The goal of the Lake Nipigon Basin planning project is "to protect, enhance and where necessary, restore the natural ecosystems, populations and wilderness quality of the Lake Nipigon Basin while allowing for tourism, recreational and industrial developments that will not compromise the integrity and environmental values of the Basin ecosystem."

Three primary land use categories are proposed for the Lake Nipigon Basin: provincial parks, conservation reserves, and enhanced management areas. These areas cover almost 370,000 hectares of land and water.

The project team is developing an Ecological Land Use and Resource Management Strategy to protect the basin ecosystems while allowing for tourism and recreational development opportunities. This is being achieved by working with the public, aboriginal groups, various agencies, and interest groups to gather background information and develop options. Opportunities for the public to actively participate in the decision-making process will be provided throughout the planning period (January 2001 to September 2002).

The Lake Nipigon Watershed Advisory Committee, a standing committee of local citizens, and the newly created Lake Nipigon Basin Aboriginal Advisory Committee, which has representation from the eight aboriginal communities in the area, will also be instrumental in the decision-making process.

To date, a background document and management options discussion paper have been developed and two series of public information centres have been held. Comments on the management options paper were received in March 2002 and preparation is underway to develop a preliminary management strategy for Spring 2002. Further public consultation will occur at this stage and a final management strategy will be developed.

Lake Superior Highlands Inventory and Community Initiative

Hat Point, Minnesota
Photograph by Patrick T. Collins, Minnesota Department of Natural Resources

This project was coordinated by The Nature Conservancy of Minnesota with funding from U.S. EPA's Great Lakes National Program Office. This project helped launch a major new conservation program for the region along Minnesota's Lake Superior shoreline. The work began with identification of landscape study areas in each Land Type Association in the North Shore Highlands Subsection to target areas for further inventory of biological diversity of the Subsection. Inventory work was conducted by staff from MN DNR's County Biological Survey. It included collaboration with numerous scientists, land managers, community leaders, and landowners to gather information and communicate results of the survey so inventory data could begin to be used to achieve conservation objectives. Resulting accomplishments included helping to develop the St. Louis River Habitat Plan, identification and protection of 3,000 acres of ecologically-significant forest areas within the Manitou Landscape Study Area, establishment of a collaborative partnership in the Manitou Landscape to manage lands and waters within ecological parameters, initiation of agreements to protect significant aquatic features along the Pigeon River, and development of a memorandum of understanding between The Nature Conservancy (TNC) and the City of Duluth to use inventory data to develop a natural area designation of ecologically significant city-owned lands. This work formed the basis for the Minnesota portion of TNC's Great Lakes Ecoregion Plan, which is the first comprehensive plan for the conservation of the native species and natural communities of the Great Lakes.

of current invasions or to develop strategies to minimize the impact of invasive species on upland and wetland communities on a basinwide basis.

Dunes contain habitat for a number of endemic species. Dunes are threatened primarily by residential development and road construction. Most sand beaches depend on the natural processes of erosion, longshore sediment transport, and sand deposition. Interference with the hydrologic cycle and barriers to sediment transport can interfere with these critical processes.

Success Stories/Remaining Challenges

The push to develop uplands continues as local communities seek new economic development and residential development. Projects like the Lake Nipigon Basin Signature Site (see box) are providing a new model for future upland protection and restoration work. Leadership by local communities and partnerships with federal, state, and provincial agencies and Tribal/First Nation groups are essential to the long-term protection of upland habitat.

Many people think of wildlife in terms of species such as deer, grouse, ducks, and songbirds. They

Bald Eagle
Photograph courtesy of The Canadian Wildlife Service

think less often of wildlife in terms of plants, herptiles, and microorganisms and their functions in the overall ecosystem. Many questions remain about the effects of contaminants on amphibians, reptiles, and mammals as well as the roles that invertebrates and microorganisms play in terrestrial ecosystem health.

One of the biggest challenges concerning management of mammals is to define which mammalian community structure represents a "healthy, sustainable wildlife community." The community profile of ungulates has changed because of alterations in land use and elimination of predators. The major question in restoration of northern forests revolves around whether current conditions represent a healthy wildlife community. Mammals are significantly affected by changes in land cover as development encroaches on their habitat. Some mammals like the caribou are negatively affected by forest fragmentation, while the populations of mammals that thrive on forest edges are increasing as forest edges increase.

Lake Superior forests provide very important habitat for migratory songbird populations, some of which probably serve as source populations for other areas. With concerns expressed across the continent about the decline of neotropical migrant birds, the Lake Superior basin should be considered an important region for migratory songbird conservation. Significant work continues on population monitoring, some of which is being linked to habitat changes on the landscape scale.

Amphibians and reptiles may be highly observable at certain times of the year and are also harvested, yet they have been essentially ignored in management plans in the past. Because the Binational Program is concerned with overall ecosystem health, closer attention should be paid to amphibians and reptiles during inventories, planning, and monitoring.

Inland Lakes and Tributaries

Literally thousands of inland lakes are found in the Lake Superior basin. These lakes range in size from small, winter kill lakes to Lake Nipigon which has a surface area of 448,000 hectares. Fish communities in the inland lakes and tributaries range from cold-water trout and whitefish communities lakes to warm-water bass and bluegill complexes.

The principal threat to inland lakes and tributaries is shoreline development. Although the human population in the Lake Superior basin has remained steady or has fallen slightly, recreational and summer home construction continues to grow. The resulting development disturbs basin soils and increases erosion and runoff to lakes and tributaries. Maintenance of developed properties may also increase deposition of pesticides to the lake.

Additional stresses include overfishing and exploitation of individual water bodies. Such practices result in reduction in the abundance of important fish species and alterations in the predator-

Project WILDSPACE™

For over 30 years, Canadian Wildlife Service has studied wildlife in Ontario and beyond, particularly bird species and their habitat in Canada. Project WILDSPACE™ was initiated in 1996 to develop a repository for wildlife data that would be accessible for use as a decision support system. The WILDSPACE™ web site (http://wildspace.ec.gc.ca/intro-e.html) provides access to this information by supporting searches by name (Species Search) or by an area on a map (Spaces Search). The Lake Superior Workgroup is considering how best to maintain the Lake Superior GIS (http://oden.nrri.umn.edu/lsgis/index.htm) and potential linkages with Project WILDSPACE™.

prey balance that may in turn result in stunted populations of panfish.

Iron ore mining also continues in the basin, although at reduced levels. Historically, mining practices have been associated with reduction in water quality and increased acidification of lakes, which decreases fish reproduction.

Success Stories/Remaining Challenges

Funding is being devoted for controlling nonpoint sources of contamination for lakes and streams. Michigan has provided more than $900,000 for projects addressing nonpoint source pollution and sediment control. The legislation under which the funds are provided requires a watershed management plan. Funded projects include the Munising Bay Watershed Project and the Central Lake Superior Watershed Partnership.

Wisconsin is funding local watershed organizations to develop watershed plans and strategies to help reduce the hydrological degradation common to the red clay watersheds of the south shore of Lake Superior.

Addressing inland lake and tributary stressors will also require actions at the federal, provincial, state, and Tribal/First Nation Levels, such as the following:

- In Minnesota, develop new policies with the timber industry to require use of best management practices to protect water quality
- In Wisconsin, purchase undeveloped shorelines and protect them
- In Ontario, conduct long-term experiments to evaluate the effect of logging on boreal forest lakes
- Develop monitoring programs to evaluate the status of important fish species

These actions will in turn support local management initiatives such as the Lake Nipigon Basin Signature Site.

Photograph courtesy of the Canadian Wildlife Service

Next Steps

The greatest opportunity for addressing habitat and land use change is to reach out to local units of government and provide them with information and tools so that their local land use decisions will help fulfill the Lake Superior Vision statement. Most successful projects are conducted at the local level with strong participation from local communities and in cooperation with state, provincial, Tribal/First Nation, and federal agencies. A greater effort needs to be made to build coalitions that together can work to restore the Lake Superior ecosystem as a dynamic entity.

In addition, a comprehensive set of ecosystem targets should be developed to guide management actions over the long term. In keeping with the public's recommendation of integrating the habitat, terrestrial wildlife, and aquatic committees, the three committees have started work on developing a set of ecosystem goals. The ecosystem goals being developed are for (1) uplands, (2) wetlands, (3) tributaries and inland lakes, (4) open lake, and (5) basin-wide considerations. Specific draft examples are provided below.

Uplands: Provide sources of native plants and seeds in an ecologically appropriate manner for use in restoration projects by 2006. Write and implement ecologically based integrated watershed management plans for all watersheds in the Lake Superior basin by 2025.

Great Blue Heron
Photograph courtesy of The Canadian Wildlife Service

Wetlands: Create and distribute a spatial database of coastal wetlands organized by type and condition and identify areas where restoration can occur by 2006. Restore 25 percent of the degraded wetland acreage in the Lake Superior basin by 2010.

Tributaries and Inland Lakes: Restore or protect 25 percent of the riparian conifer forest acreage by 2010. Rehabilitate 50 percent of 64 tributaries to Lake Superior in order to achieve Fish Community Objectives for indigenous lake trout, brook trout, walleye, and lake sturgeon. Rehabilitate the remaining tributaries by 2050.

Open Lake: By 2006, implement lake-wide acoustics monitoring to measure the abundance and species composition of the pelagic fish community. By 2010, quantify and describe the bottom substrates in 50 percent of Lake Superior waters that are less than 30 meters deep, and by 2015, quantify and describe the bottom substrates in the remaining waters that are less than 30 meters deep.

Basin-Wide: Develop and establish a unified, binational, GIS-based database that includes the most current and functioning basin-wide decision support models needed for ecosystem and watershed management and methods for providing data access and distribution by 2006. Complete an inventory and control plan for existing priority exotic species in the Lake Superior basin by 2010. By 2020, transfer knowledge of best management practices and LaMP goals to all affected units of government (townships, counties, and municipalities) within the 15 watersheds of Lake Superior.

Achieving Success: Strategies for Improving the Lake Superior Ecosystem

Although the status of the Lake Superior ecosystem is mixed, much work remains to improve the health of Lake Superior and its watershed. A number of success stories described in this section have resulted in improvements to the Lake Superior ecosystem. Although these successes involve a variety of partners, habitat types, and remedial activities, they have several common elements. Learning from these successes will help foster greater Lake Superior ecosystem improvements in the future. The common elements of the success stories include the following:

Strengthening Planning - Most stressors associated with problems in the Lake Superior basin are caused by human activities. As noted above, local land use plans should focus on protecting and restoring ecosystems and natural communities while at the same time maintaining the economic viability of human communities.

Developing a More Complete Inventory of Environmental Assets and Problems - Significant ecological inventory needs exist in the Lake Superior basin. For example, the extent of exotic species infestation of terrestrial ecosystems is still largely unknown.

Monitoring the Ecosystem More Effectively - Although the participants in the Binational Program have made much progress in identifying and testing monitoring protocols, there is a further need to refine and implement monitoring techniques and strategies. Several community-based indicators do not have standardized monitoring protocols.

Restoring and Maintaining Important Habitat - The Lake Superior basin has numerous important habitat sites. The locations of these sites have been stored in a spatial database on a GIS. Conservation actions should be implemented to maintain habitat function and structure at these habitat sites, and habitat restoration projects should use native plant species. Strategies should be developed for protection, maintenance, and restoration of ecologically important wildlife species and communities, and restoration plans for threatened or endangered species should be fully implemented. In addition to identifying high-quality habitat sites, the Binational Program should identify sites that have lost their ecosystem function or structure.

Improving Public Outreach and Education - Public outreach and education form one of the most important strategies for meeting the goals of LaMP 2000 and the Binational Program. It is critical to communicate the Lake Superior ecosystem approach as well as the vision and management plan developed for the basin. There should be greater emphasis on communicating with local governments and land management agencies so that the goals of LaMP 2000 can be incorporated into local laws and land use plans.

Reducing Contaminant Loads - Persistent contaminants affect wildlife and the habitat where they live. Although considerable information is available on the human health effects resulting from exposure to many contaminants, these substances may have detrimental effects on native flora and fauna. More effective biological indicators should be identified for contaminants in the ecosystem, particularly for plants and wildlife. These indicators should be identified in addition to the species that are most susceptible to the contaminants.

Increasing Research Efforts - Basin-wide research gaps should be identified with the cooperation of individuals and organizations on both sides of the international border. Groups of scientists should meet to prioritize research topics, and agencies should define and fund projects that address the research gaps, especially those associated with high-priority issues.

Securing Additional Funding - To meet the goals and vision of LaMP 2000 and the Binational Program, a more effective strategy should be developed to identify diverse funding sources that can be leveraged to secure additional funding.

Cloquet River, Minnesota
Photograph by Patrick T. Collins,
Minnesota Department of Natural Resources

Isle Royale National Park, Michigan
Photograph by Patrick T. Collins,
Minnesota Department of Natural Resources

Section 5:

Integrating Great Lakes and Lake Superior Management Activities

Grand Sable Dunes
Photograph by Jeffrey Foltice, Michigan Travel Bureau

Since the release of LaMP 2000, much effort has gone into integrating and coordinating LaMP activities and other toxics reduction, human health, monitoring, and pollution prevention programs in the Great Lakes basin. Specifically, the following efforts have been initiated since April 2000: (1) addressing human health concerns, including developing a Great Lakes Human Health Network, holding a Great Lakes Beach Conference, and making progress in implementing fish consumption advisories; (2) beginning to develop a coordinated binational Great Lakes monitoring strategy; (3) promoting further mercury reduction and retirement efforts in conjunction with national and international efforts; (4) coordinating and integrating activities with the Great Lakes Binational Toxics Strategy and the Lake Superior Forum; and (5) improving the linkages between the LaMP and RAP development for Lake Superior AOCs.

Human Health

LaMP 2000 focused on addressing human health concerns associated with contaminants in the Lake Superior basin. The LaMP Human Health Committee gathered studies, data, expertise, and public health information to create a comprehensive LaMP chapter on human health. The chapter also presented a work plan for implementing programs, projects, research, and outreach activities to protect and improve human health in the Lake Superior basin. However, progress on these activities has been limited because of agency resource constraints.

Efforts to better protect human health in the basin face challenges similar to those associated with protecting the entire Lake Superior ecosystem. Local leadership is critical to ensure that people receive information concerning threats to human health. In addition, continuing research on the dangers posed by contaminants is critical to protecting human health, as is the distribution of relevant information locally.

Human Health Network

At the May 2001 Binational Executive Committee (BEC) meeting, the Lake Superior Task Force and Workgroup recommended that a Great Lakes-wide human health network be formed to maximize resources and efficiencies of scale. BEC agreed with their recommendation to form such a network, with U.S. EPA's GLNPO providing the staff resources for a year.

The human health network will bring together experts from throughout the basin to share information and provide technical assistance on human health issues. The network will be holding initial meetings to discuss terms of reference, its mission, and other details. In the interim, preliminary work on human health issues has begun, including the holding of a Great Lakes Beach Conference.

In addition, information to support the network will be obtained through the National Health and Nutrition Examination Survey (NHANES).

NHANES is a survey conducted by the National Center for Health Statistics and the Centers for Disease Control and Prevention to collect information about the health and diet of people in the United States. In March 2001, the "National Report on Human Exposure to Environmental Chemicals" was released, providing a compilation of ongoing biomonitoring exposure data for both the general U.S. population and special-exposure populations within the United States. For more information, see http://www.cdc.gov/nceh/dls/report/.

Great Lakes Beach Conference

The Great Lakes Beach Conference was held in Chicago in February 2001 and was jointly sponsored by U.S. EPA Region 5 and the City of Chicago. The focus of the conference was the science and technology of beach monitoring and closure, beach management, and resources to support beach programs. Breakout sessions at the conference provided opportunities for interactive discussions focused on developing specific recommendations for policy, regulatory, and technical needs to support beach management programs for the Great Lakes, Lake St. Clair, and inland beaches.

Photograph by Patrick T. Collins,
Minnesota Department of Natural Resources

At the conclusion of the conference, U.S. EPA presented a technical workshop on the Federal Beach Bill that was passed in early 2001. This workshop provided conference participants with the opportunity to understand the purpose of the beach bill and the funding available under the bill. Additional information regarding the Federal Beach Bill is available at *http://www.epa.gov/OST/beaches*.

Progress on Fish Consumption Advisories

Significant progress has been made in further developing and implementing fish consumption advisories in the Lake Superior basin. Federal, state, provincial, and tribal government actions have focused on two areas: (1) outreach and education regarding fish consumption advisories to at-risk populations and (2) chemical monitoring of fish tissues.

- The Agency for Toxic Substances and Disease Registry (ATSDR) has provided funding to state and tribal agencies to assist them in communicating fish consumption advisory information. A consortium of Great Lakes states developed outreach materials for women of childbearing age and minority groups. These outreach materials have been adapted by each of the states for their specific needs and are being distributed at women's and children's clinics, health fairs, state fairs, and fishing shows to increase health advisory awareness. The Great Lakes Indian Fish and Wildlife Commission (GLIFWC) is distributing GIS-based maps to its member tribes depicting the levels of mercury in walleye in various lakes.

- With funding from the U.S. EPA's Coastal Environmental Mangement Program as well as other funding sources, the Fond du Lac Band, Grand Portage Band, and Minnesota Departments of Health and Natural Resources worked together to analyze fish collected from reservation waters and to report those results the to tribal members in a culturally appropriate manner.

- GLIFWC has analyzed commercially harvested species of Lake Superior fish with a focus on the chemical reductions achieved by trimming and processing fish fillets with funding from the Administration for Native Americans as well as other funding sources. Outreach materials and U.S. Food and Drug Administration hazard analysis and critical control point seafood safety

information were used to communicate the findings.

- A pilot fish consumption indicator was proposed at the SOLEC in 2000. SOLEC Indicator 4083, "Chemical Contaminants in Edible Fish Tissue," would promote reporting of contaminant levels in edible portions of fish collected by state agencies responsible for issuing fish consumption advisories. The indicator would also be used to track these contaminant levels over time.
- The amounts and pathways of exposure to chemical contamination in Lake Superior are understudied. GLIFWC and the 1854 Authority are undertaking separate studies to document the amount of fish consumed by tribal members. GLIFWC's study is in its fifth year.

Coordinated Great Lakes Monitoring Strategy

The Lake Superior Binational Program has initiated many excellent monitoring efforts and programs as documented in the proceedings of the Lake Superior

Photograph courtesy of the Ontario Ministry of Natural Resources

Monitoring Workshop held in October 1999. However, a real need exists for better coordination and collaboration efforts across the Great Lakes basin to promote data comparability, enhance data utility, maximize resources, and conduct efficient and timely reporting on environmental change and progress. To help address this need, the BEC requested agencies to investigate the opportunity to enhance monitoring coordination and to prepare a status report for the BEC's summer 2002 meeting and a set of options for the fall 2002 meeting.

In the interim, monitoring meetings were held in the United States in January 2002 and in Canada in February 2002 to discuss the monitoring needs for the Great Lakes individually and as a whole. Specifically, these meetings set the stage for initial development of a Great Lakes basin-wide monitoring strategy.

Promotion of Mercury Reduction Efforts

To ensure that the Lake Superior mercury reduction goal of 80 percent by 2010 is reached, the Lake Superior Workgroup and Task Force asked the BEC to take a leadership role in further promoting mercury reductions at mining operations, utilities, and other coal combustion sources. The BEC agreed to highlight and promote mercury reduction activities through the regular course of its national and international meetings. BEC's new leadership role will help highlight and promote specific issues of major importance to the Lake Superior Binational Program.

Integration with Binational Toxics Strategy and Binational Forum

Steps have been taken to improve coordination between the Lake Superior LaMP and the Binational Toxics Strategy and Lake Superior Binational Forum:

- A joint Binational Toxics Strategy-LaMP meeting was held in November 2001 to discuss joint priorities, projects, and activities. Planning for a joint meeting on long-range air transport of pollutants is underway.
- A joint Lake Superior Binational Forum, Workgroup, and Task Force meeting was held in November 2001 to celebrate the ten-year anniversary of the Lake Superior Binational Program. The joint meeting was attended by over 70 people from local, state, federal, Tribal/First Nations, provincial, and citizen groups. Key focus areas included outreach and information to influence land use decisions, mercury retirement, human health concerns, and burn barrels.

LaMP and RAP Connections

In addition to development of LaMPs, the 1987 amendments to the GLWQA called for development of RAPs for specific AOCs. Information on the Lake Superior AOCs is provided in Appendix A. The LaMPs focus on those environmental problems that are lakewide in nature and that need a combined Canadian and U.S. effort to be resolved. A RAP, however, encompasses a much smaller geographic area, concentrating on a single embayment, watershed, or stretch of the river. Most of the beneficial use impairments associated with Lake Superior can be directly related to sources within the AOCs. Any improvement in an AOC will eventually help to improve Lake Superior as a whole, but the local effect may be more immediately visible and measurable. Implementation of most RAPs has been underway for a number of years using a combination of federal, state, provincial, and local resources.

Forging a strong relationship between LaMPs and RAPs is important to the success of both programs. In 2001, with a view to improving program coordination, Environment Canada's Restoration Programs Division reorganized to strengthen the LaMP and RAP linkage. Division staff members are now organized by lake, with a Lake Coordinator being responsible for both the LaMP and the lake-specific AOCs. Efforts are also underway to better coordinate work plans generated by various branches within Environment Canada.

Photograph by Carol Y. Swinehart,
Michigan Sea Grant Extension

Section 6:

Conclusion

As described in the Vision Statement for Lake Superior, the lake is "a worldwide model for resource management." It is the cleanest and least developed of the Great Lakes, and it is the only lake for which a goal of zero discharge of critical pollutants has been established. An aggressive timeline for meeting that goal by 2020 has been set.

Lake Superior has had some notable successes. The 60 percent mercury emission reduction target has been met; lake trout populations have been restored to historical levels; and 29,000 acres of land along the St. Louis River and its tributaries in Wisconsin and Minnesota has been protected, among other things. These successes as well as the scores of other activities described in this report represent significant progress in achieving the vision for Lake Superior. However, much more needs to be done. Not all interim goals for achieving zero discharge have been met; critical habitat continues to be lost to development; and a large number of expensive projects, including cleanups of contaminated sediments, remain to be initiated.

The Lake Superior Binational Program continues to demonstrate its resilience as a successful partnership focused on making a safe and healthy Lake Superior environment where

- We can all eat any fish.
- We can swim in the water.
- We can drink the water.
- All habitats are healthy, naturally diverse, and sufficient to sustain viable biological communities.

Apostle Islands National Lakeshore, Wisconsin
Photograph by Meg Turville-Heitz,
Wisconsin Department of Natural Resources

The Next Steps

To ensure continued progress toward achieving a sustainable and healthy Lake Superior ecosystem, the LaMP will continue to emphasize key, long-term goals, including achieving zero discharge, developing a strategy for reducing out-of-basin sources of pollution, engaging Lake Superior basin communities in fulfilling the Binational Program's vision for the lake, increasing citizen participation in conservation activities and practices, coordinating local land use planning, gathering data on sustainability indicators, and encouraging and pursuing more diverse economic development strategies.

Common Tern
Photograph by Sumner Matteson,
Wisconsin Department of Natural Resources

To achieve these goals, the government partners on the LaMP committees have identified a series of highest-priority needs and activities for Lake Superior (for a complete list of actions, see LaMP 2000). These include the following:

- Encouraging better land use practices and developing watershed management plans to decrease the threats to habitat associated with development and forest fragmentation
- Decreasing the transport of exotic species into the basin ecosystem and controlling the populations of existing exotic species
- Restoring natural flows to tributaries
- Decreasing emissions of toxic substances in the basin
- Developing strategies for decreasing the transport of out-of-basin pollutants into the basin
- Eliminating mercury from products used in the basin
- Eliminating improper incineration in burn barrels, which releases mercury and dioxins
- Increasing public outreach and education programs promoting the goals of LaMP 2000
- Remediating contaminated sediments
- Developing a human health network
- Developing achievable goals for the broader ecosystem program

Building Broader Partnerships at the Local Level

Although the federal, state, provincial, and tribal governments have been effective in setting the broad goals for the LaMP and in identifying government initiatives, the key to achieving the LaMP 2000 goals and priorities lies in involving communities and individuals in Lake Superior protection and restoration. The most successful recent efforts to restore basin ecosystems and reduce pollution have involved partnerships between local communities and appropriate state, provincial, Tribal/First Nations, and federal agencies. These partnerships have been especially effective in restoring and protecting habitat, such as at Whittlesey Creek, Sugarloaf Cove, and Lake Nipigon.

The need for local action is also becoming increasingly important for the control of critical pollutants. The ZDDP will succeed only if the residents of the Lake Superior basin are aware, informed, and willing to make changes. For example, use of burn barrels must be controlled, and alternatives to mercury-containing products must be promoted. Programs that target industrial sources will bring about large reductions in critical pollutant emissions, but getting to zero means changing from a consumer society to a conserver society within the basin. Moreover, in-basin efforts alone will not achieve reduction targets. Further efforts outside the basin are also needed.

The water, air, land, plants and animals of the Lake Superior ecosystem should be viewed as resources of global importance. The decisions we make today regarding where to spend our limited funds and how to shape our society will influence the ability of subsequent generations to live healthy and productive lives. Developing sustainability in the region depends on forging durable partnerships among government, industry, and local citizens in Canada and the United States. The progress made to date demonstrates that the Lake Superior ecosystem can be protected and restored. If we work together to address the multiple stressors affecting Lake Superior, the world's largest lake can serve as an international model for resource management and truly remain the "greatest" of the Great Lakes.

For More Information….

For more information on the Lake Superior Binational Program, consult the following web sites: www.on.ec.gc.ca/glimr/lakes/superior and http://www.epa.gov/glnpo/lakesuperior/index.html.

Additional information on the Lake Superior Binational Forum is available at 1-888-301-LAKE.

The following web sites provide additional information on efforts to restore and protect the Lake Superior ecosystem:

- Great Lakes Fisheries Commission, Lake Superior Committee: *http://www.glfc.org/lakecom/lsc/lstc.htm*
- Great Lakes Information Network, Lake Superior Page: *http://www.great-lakes.net/lakes/superior.html*
- Lake Superior Binational Forum: *http://www.northland.edu/soei/LSBF*
- National Wildlife Federation, Lake Superior Page: *http://www.nwf.org/lakesuperior*
- Lake Superior Habitat Coordination: *http://www.d.umn.edu/~pcollins/main.html*
- St. Louis River Citizens Action Committee: *http://www.stlouisriver.org*
- Walk Around Lake Superior: *http://www.protecttheearth.com/lakewalk.html*
- Western Lake Superior Sanitary District: *http://www.wlssd.duluth.mn.us*
- EcoSuperior: *http://www.ecosuperior.com*
- Lake Superior Decision Support Project: *http://oden.nrri.umn.edu/lsgis/index.htm*

Appendix A
Lake Superior Areas of Concern

For more information, visit the AOC website *http://www.on.ec.gc.ca/glimr/raps/aoc-map.html*

AOC Name	Primary Contaminants	Geographic Area	Stressors	Beneficial Use Impairments	Programs	Clean-Up Actions Completed	Key Activity Needed	Barrier	Next Steps
Deer Lake **Michigan**	• Mercury	A 906-acre impoundment in central Marquette County, Michigan that includes the Carp River watershed comprised of Carp Creek, Deer Lake, and the Carp River downstream 20 miles to Lake Superior at Marquette.	• Contaminated sediments • Copper mining waste material	• Fish and wildlife consumption restrictions • Dredging activities restrictions	• Dredging	• Sewer separation and primary treatment plants secondary wastewater treatment	• Identify and restore beneficial uses of the Carp River watershed	• Funding sources to manage sediment and contamination issues on an AOC-wide, bi-state basis • Funding sources to eliminate Sanitary sewer overflows	• Complete analysis of beneficial use impairments • Complete contaminated sediment feasibility study • Identify other contaminated sites • Urban watershed storm water management • Sanitary sewer improvements • Implement Habitat Management Plan
Jackfish Bay **Ontario**	• Solids (i.e., wood fiber) • AOX	The 14 km reach of Blackbird Creek between Kimberly-Clark Canada Inc. pulp mill and Jackfish Bay, including Lake A, Moberly Lake and Jackfish Bay itself.	• Wastewater discharges • Nonpoint source pollution • Spills • Contaminated sediments	• Fish and wildlife consumption restrictions • Fish and wildlife degradation • Fish tumors or other deformities • Bird or animal deformities or reproductive problems • Degradation of benthos • Aesthetics degradation • Loss of fish and wildlife habitat	• Great Lakes Sustainability Fund	• Effluent quality from paper mill improved • Chlorine dioxide bleaching plant upgraded resulting in lower AOX levels (not 100% of time)	• Eliminate mill discharge from ecosystem cycling	• Natural recovery takes time • Available technology needs to be utilized at all times	• Continued natural recovery and monitoring
Nipigon Bay **Ontario**	• Solids • Pathogens • Biological oxygen demand (BOD)	A large portion of Nipigon Bay and the Nipigon River downstream of Alexander Dam. Two communities are located in the vicinity of the Bay: Red Rock (population: 1,400) and Nipigon (population: 2,400).	• Wastewater discharges • Nonpoint source pollution	• Fish and wildlife population degradation • Degradation of benthos • Eutrophication or undesirable algae • Aesthetics degradation • Loss of fish and wildlife habitat	• Great Lakes Sustainability Fund • Canada-Ontario Infrastructure Program	• Created water management plan for Nipigon River to regulate hydroelectric facilities' water use to help restore brook trout • Land use strategy under development	• Upgrade primary STPs in Redrock and Nipigon	• Lack of dedicated resources	• Continued education and stewardship activities • Work toward STP upgrades
Peninsula Harbour **Ontario**	• Mercury	Peninsula Harbour proper, and a portion of open Lake Superior immediately south of the peninsula.	• Wastewater discharges • Contaminated sediments • Loss of fish nursery and habitat • Loss of wetlands	• Fish and wildlife consumption restrictions • Fish and wildlife degradation • Degradation of benthos • Dredging activities restrictions • Loss of fish and wildlife habitat	Great Lakes Sustainability Fund	• Pulp kraft mill installed secondary treatment for effluent	• Complete contaminated sediment assessment		• Complete feasibility study

Lake Superior Areas of Concern

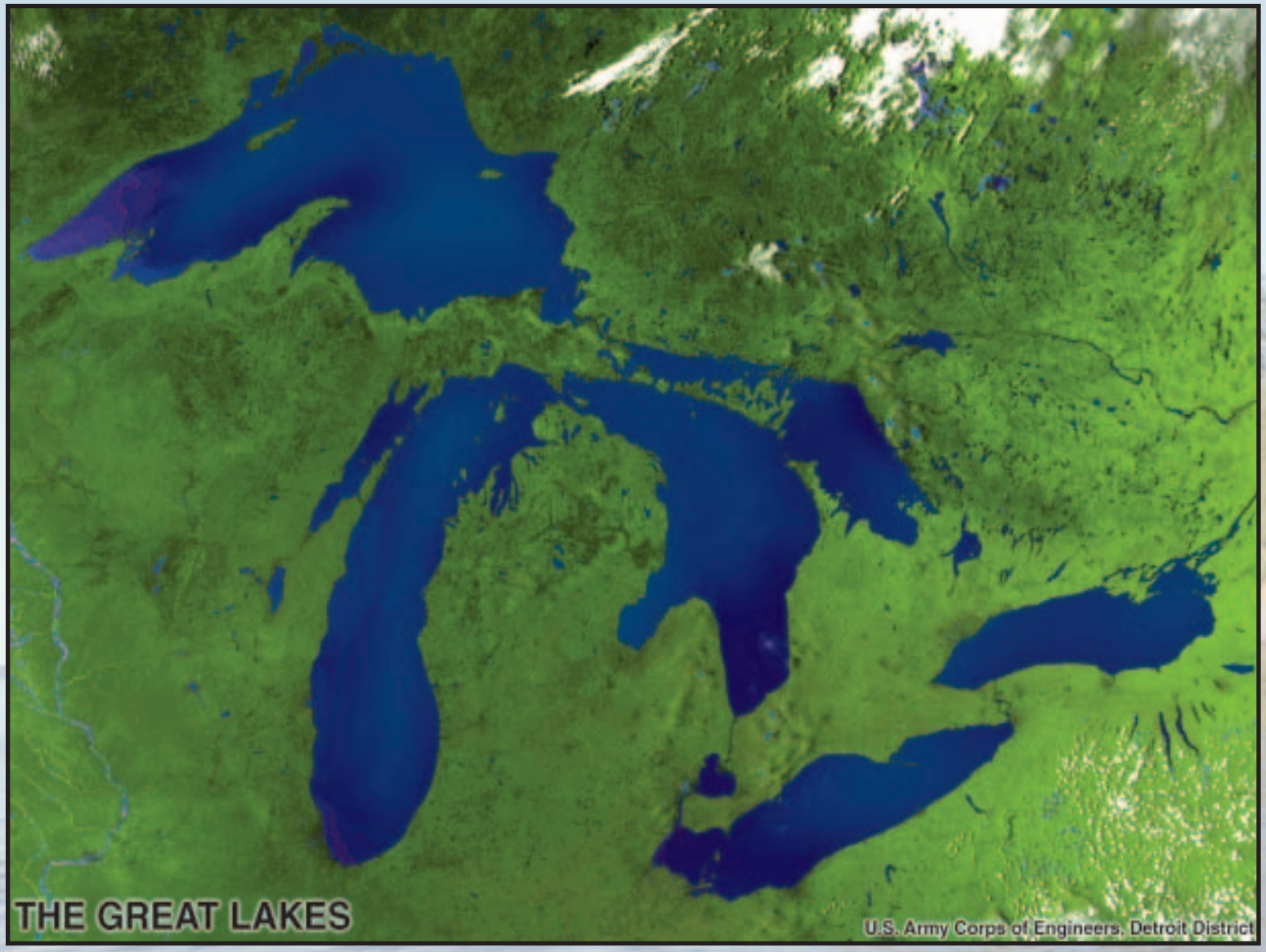
(continued)

AOC Name	Primary Contaminants	Geographic Area	Stressors	Beneficial Use Impairments	Programs	Clean-Up Actions Completed	Key Activity Needed	Barrier	Next Steps
St. Louis River **Minnesota/ Wisconsin**	• Pathogens • Mercury • PCBc • Nutrients •PAHs	St. Louis Bay, the Nemadgi River basin and the St. Louis River Basin to Cloquet, Minnesota	• Contaminated sediments • Abandoned hazardous waste sites • Poorly designed or leaky landfills • Industrial discharges chemical spills, • Improperly sewered wastes • Municipal and industrial runoff •Turbidity	• Fish and wildlife consumption restrictions • Fish and wildlife degradation • Fish tumors or other deformities • Degradation of benthos • Dredging activities restrictions • Eutrophication or undesirable algae • Beach closings • Aesthetics degradation • Loss of fish and wildlife habitat	• Superfund • Navigational dredging •RCRA - CA •Wisconsin Great Lakes Protection Fund •Minnesota Great Lakes Protection Fund •NRDA • Minnesota and Wisconsin Coastal Management Programs	• Wastewater treatment • Sediment contamination studies to identify hotspots •Evaluation of cleanup options at two Superfund sites •Prioritization of remaining hotspots per the Stage 2 Sediment Assessment Strategy •Habitat Management Plan	• Dredging	• Lack of dedicated resources •Lack of funding sources to manage sediment contamination issues on an AOC-wide, bi-state basis.	• Contaminated site remediation • Mercury reduction • Habitat restoration and protection
St Marys River **Michigan/ Ontario**	• PAHs • Mercury •Arsenic • Cyanide •Phosphorus •Benzene •Toluene •Oil and grease • Phenols • Ammonia • Pathogens	From the head of the river at Whitefish Bay (Point Iroquois - Gros Cap), downstream through the St. Joseph Channel to Humburg Point on the Ontario side, and to the straits of Detour on the Michigan side.	• Combined sewer overflows • Loss of wetlands • Point and nonpoint source pollution • Wastewater discharges • Urban/industrial development • Navigational structures	• Fish and wildlife consumption restrictions • Fish and wildlife degradation • Fish tumors or other deformities • Degradation of benthos • Dredging activities restrictions • Eutrophication or undesirable algae • Beach closings • Aesthetics degradation • Loss of fish and wildlife habitat	• Superfund • Clean Water Act • Navigational dredging •Canada-Ontario Infrastructure Program	• One superfund site restored • Combined sewer separation for Sault Ste. Marie, Michigan. • Steel and paper mills in Sault Ste. Marie, ON improved quality of effluent • Environmental Management Agreement among Algoma Steel, Canada and Ontario •Infrastructure upgrades by Sault Ste. Marie, Ontario.	• Complete contaminated sediments assessment • Upgrade East End STP to secondary treatment		• Superfund monitoring at cleaned site • Implementation of sediment management program

Lake Superior Areas of Concern

(continued)

AOC Name	Primary Contaminants	Geographic Area	Stressors	Beneficial Use Impairments	Programs	Clean-Up Actions Completed	Key Activity Needed	Barrier	Next Steps
Torch Lake **Michigan**	• Copper • Mercury • Arsenic • Lead • Chromium • Heavy metals	The lower portion of the Keweenaw Peninsula, totaling approximately 368 square miles, encompassing the Keweenaw Waterway, (North Entry Harbor of Refuge, Portage Lake, and Torch Lake), its watershed, portions of two other adjacent watersheds (Trout River and the Eagle River Complex), and several miles of its western Lake Superior shoreline	• Contaminated sediments • Copper mining waste material	• Fish and wildlife consumption restrictions • Degradation of benthos • Dredging activities restrictions • Drinking water consumption restrictions, or taste or odor • Aesthetics degradation • Loss of fish and wildlife habitat	• Superfund • Dredging	• One Superfund site restored • Breached mine stabilized	• Dredging	• Lack of dedicated resources	• Superfund site remediation • Sediment remediation
Thunder Bay **Ontario**	• Pathogens • Mercury and other metals • Dioxins and furans • PCP • PAHs	About 28 km along the shoreline and up to 9 km offshore.	• Contaminated sediments • Industrial and municipal sewage • Nonpoint pollution	• Fish and wildlife consumption restrictions • Fish and wildlife degradation • Degradation of benthos • Dredging activities restrictions • Beach closings • Aesthetics degradation • Phytoplankton and zooplankton population degradation • Loss of fish and wildlife habitat	• Canada-Ontario Infrastructure Program • Great Lakes Sustainability Fund	• Process improvements and enhanced effluent treatment at four pulp and paper mills • Northern Wood Preservers remediation	• Nonpoint pollution prevention • Upgrade STP from primary to secondary • Incorporate RAP water use goals into official plans and new waterfront developments		• Complete contaminated sediment assessment for harbour adjacent to Provincial Papers



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1854 Authority
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Great Lakes Indian Fish and Wildlife Commission
Keweenaw Bay Indian Community
Michigan Department of Environment Quality
Michigan Department of Natural Resources
Minnesota Department of Natural Resources
Minnesota Department of Health
Minnesota Pollution Control Agency
Ontario Ministry of Natural Resources
Ontario Ministry of the Environment
Parks Canada
Red Cliff Band of Lake Superior Chippewa
U.S. Environmental Protection Agency
U.S. Fish and Wildlife Service
U.S. Forest Service
U.S. National Park Service
Wisconsin Department of Natural Resources

The Lake Superior LaMP: 2002 Progress Report will be available at:
http://www.epa.gov/glnpo/lakesuperior
and **www.on.ec.gc.ca/glimr/lakes/superior**